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Modern Surgery - Chapter 15. Contusions and Wounds

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XV. CONTUSIONS AND WOUNDS.

Contusions.—A contusion or bruise is a subcutaneous laceration, due to the application of blunt force, the skin above it being uninjured or damaged without a surface-breach and blood being effused. Punches, kicks, blows from a blackjack, etc., cause contusions. In intra-abdominal contusions the skin of the abdomen is frequently not damaged. In contusions of structures overlying a bone the skin suffers with the deeper structures. If a large vessel is ruptured, hemorrhage is profuse and much blood gathers in the tissue. If only small vessels suffer, hemorrhage is moderate. An *ecchymosis* is diffuse hemorrhage over a large area, the blood lying in the spaces of the subcutaneous or submucous areolar tissue. A very small ecchymosis is known as a *petechia;* a very large ecchymosis is called a *suffusion* or *extravasation.* A *hematoma* is a blood-tumor or a circumscribed hemorrhage, the blood lying in a distinct cavity in the tissue. In extremely severe contusions tissue vitality may be destroyed or so seriously impaired that gangrene follows. Suppuration rarely occurs, but occasionally does so, and is most apt to in a drunkard or a person of dilapidated constitution. When hemorrhage arises in the tissues after a contusing force it soon ceases unless a very considerable vessel is ruptured. The arrest of hemorrhage is brought about by the resistance of the tissues, the contraction and retraction of the vessels, by coagulation of blood, and in some cases of severe injury coagulation is favored by syncope. Blood in the tissues, as a rule, soon coagulates, the fluid elements being absorbed and the red corpuscles breaking up and setting free pigment, which pigment may be carried away from the seat of injury or may crystallize and remain there as hematoidin. In some cases inflammation occurs about the extravasated blood, a capsule of fibrous tissue being formed, and the blood being slowly absorbed, or the fluid elements remaining unabsorbed (*blood-cyst*), or the blood becoming thicker and thicker, finally calcifying. Blood in serous sacs (joints, pleura, pericardium) coagulates very slowly. As blood is being absorbed it undergoes chemical changes and color-changes ensue, the part being at first red and then becoming purple, black, green, lemon, and citron. The stain following a contusion is most marked in the most dependent area. After a bruise of the periosteum a blood-clot forms, much tissue-induration occurs, and a hard edge can be detected by palpation.

Symptoms.—The symptoms are tenderness, swelling, and numbness, followed by some aching pain or a feeling of soreness. The pain rarely persists beyond the first twenty-four hours. Cutaneous discoloration appears quickly in superficial contusions, but only after days in deep ones. In some regions—the scalp, for instance—it can scarcely be detected; in others, as in the eyelid and vulva, discoloration is early, widespread, and marked. Discoloration and swelling are very marked in regions where loose cellular tissue abounds (eyelids, prepuce, scrotum). The discoloration is at first red, and becomes successively purple, black, green, lemon, and citron. The swelling is primarily due to blood, and is added to by inflammatory exudation. In a more severe contusion a hematoma may form. A recent hematoma fluctuates, but gradually, because of cell-proliferation, the edge becomes hard and the center

continues to fluctuate. The mass gradually grows smaller and finally disappears. A hematoma of the scalp may be mistaken for depressed fracture of the skull. It may also be mistaken for an abscess, but differs from it in the absence of inflammatory signs. It occasionally, though rarely, suppurates. In a case in which suppuration occurs an abrasion, which may be very minute, often exists on the skin. In any severe contusion there is considerable and possibly grave, or even fatal, shock.

Treatment.—In a severe injury bring about reaction from the shock. Local treatment consists in rest, elevation, and compression to arrest bleeding, antagonize inflammation, and control swelling. Cold is useful early in most cases, but it is not suited to very severe contusions nor to contusions in the debilitated or aged, as in such cases it may cause gangrene. In very severe contusions employ heat and stimulation. When inflammation is subsiding after a contusion, compression and inunctions of ichthyol should be employed. Massage and passive motion are imperatively needed after contusion of a joint. A contusion should never be incised unless the amount of blood is large and a distinct cavity exists, or hemorrhage continues, or infection takes place, or a lump remains for some weeks, or gangrene is threatened. If the amount of blood is very large, massage must not be used because it may cause embolism or fat-embolism. If a distinct cavity exists, aspiration or incision lessens the danger of fat-embolism. For persistent bleeding freely lay open the contused area, turn out clots, ligate vessels, insert drainage-strands or a tube, and close the wound. If gangrene is feared, make incisions and apply heat to the part. If a slough forms, employ antiseptic fomentations. The constitutional treatment for contusion, after the patient has reacted from shock, is the same as that for inflammation. (See Abdomen, etc.)

Wounds.—A wound is a breach of surface continuity effected by a sudden mechanical force. Wounds are divided into open and subcutaneous, septic and aseptic, incised, contused, lacerated, punctured, gunshot, stab, and poisoned wounds.

The **local phenomena of wounds** are pain, hemorrhage, loss of function, and gaping or retraction of edges.

Pain is due to the injury of nerves, and it varies according to the situation and the nature of the injury. It is influenced by temperament, excitement, and preoccupation. It may not be felt at all at the time of the injury. At first it is usually acute, becoming later dull and aching. In an aseptic wound the pain is usually slight, but in an infected wound it is always severe.

The nature and amount of *hemorrhage* vary with the state of the system, the vascularity of the part, and the variety of injury.

Loss of function depends on the situation and extent of the injury.

Gaping or *retraction of edges* is due to tissue-elasticity, and varies according to the tissues injured and the direction, nature, and extent of the wound.

The **constitutional condition** after a severe injury is a state known as *shock*.

Shock is a sudden depression of the vital powers arising from an injury or a profound emotion acting on the nerve-centers and inducing exhaustion or inhibition of the vasomotor mechanism. By overstimulation of sensory nerves the vasomotor center is exhausted or inhibited, vaso-constrictor power is lost, the arteries and capillaries are depleted or nearly emptied

of blood, and the blood is largely transferred to the veins. The blood-pressure is lowered, the cardiac action is impaired, the respiratory action is impeded, and quantities of dark-colored blood gather in the somatic veins, but especially in the veins of the splanchnic area. (See the masterly study of "Surgical Shock" by Crile.) In shock the abdominal veins are greatly distended and the other veins of the body may also be overfull, the arteries contain less blood than normal, and an insufficient amount of blood is sent to the heart and to the vital centers in the brain. In other words, in shock there is a deficiency in the circulating blood. The term *collapse* is used by some to designate a severe condition of shock, and is employed by others as a name for a condition of shock produced by mental disturbance rather than by physical injury. Crile regards collapse as inhibition of the vaso-motor center, in contrast to shock, which is exhaustion of the center. As a matter of fact, shock and collapse are often both present. Shock may be slight and transient, it may be severe and prolonged, and it may even produce almost instant death. Sudden death from shock is due to reflex stimulation of the pneumogastric nuclei and arrest of cardiac action. It is known as *death by inhibition*. Shock is more severe in women than in men, in the nervous and sanguine than in the lymphatic, in those weakened by suffering than in those who are strangers to illness. It is predisposed to by fear, by disease of the kidneys, diabetes, chronic cardiac disease, and alcoholism. Injuries of nerves, of the brain, of the intrathoracic viscera, of the intra-abdominal viscera, of the urethra, or of the testicle produce extreme shock. Anything which extracts the body-heat favors the development of shock (exposure to cold air, insufficient covering, chilling the body by solutions or wet towels). Cerebral concussion is shock plus other conditions. Sudden and profuse hemorrhage causes shock; so does prolonged anesthetization. Great shock may occur after the removal of a large tumor or a quantity of fluid from the abdomen. In such a case shock is brought about by the sudden removal of pressure and the consequent rapid distention of intra-abdominal veins. Exposure of tissue and vital parts to air aggravates shock.

Symptoms.—The symptoms of ordinary shock (*torpid* or *apathetic shock*) are subnormal temperature; irregular, weak, rapid, and compressible pulse; cold, pallid, clammy, or profusely perspiring skin; and shallow and irregular respiration. Consciousness is usually maintained, but there is an absence of mental originating power, the injured person answering when spoken to, but volunteering no statements and lying with partly closed lids and expressionless countenance in any position in which he may be placed. The pupils are dilated and react but slowly to light. The sphincters are relaxed. Pain is slightly or not at all appreciated. Nausea is absent and vomiting may, as in concussion, presage reaction. Gastric regurgitation, after a considerable duration of shock, is not unusual, and is a bad omen. Shock is not rarely followed by suppression of urine. Whereas the victim of shock is usually stupid and indifferent, he may become delirious. If delirium arises, the condition is very grave. Travers called shock with delirium *erethistic* or *delirious shock*. As a matter of fact, such a state is not genuine shock, but is either a traumatic or a toxic delirium. It is usually due to uremia or sepsis. Delirious shock is seen after a person has been bitten by a poisonous

snake. Many years ago Travers described a *secondary* or *delayed form* of shock, which comes on several hours after an injury or violent emotional disturbance. This form of shock is seen not unusually in those who have passed through a railroad accident. It may be a sign of hemorrhage, and is sometimes met with after the administration of ether or chloroform.

Diagnosis.—Concealed hemorrhage is difficult to differentiate from shock. It produces impairment of vision (retinal anemia), irregular tossing, frequent yawning, great thirst, nausea, and sometimes convulsions. In shock the hemoglobin is unaltered; in hemorrhage it is enormously reduced (Hare and

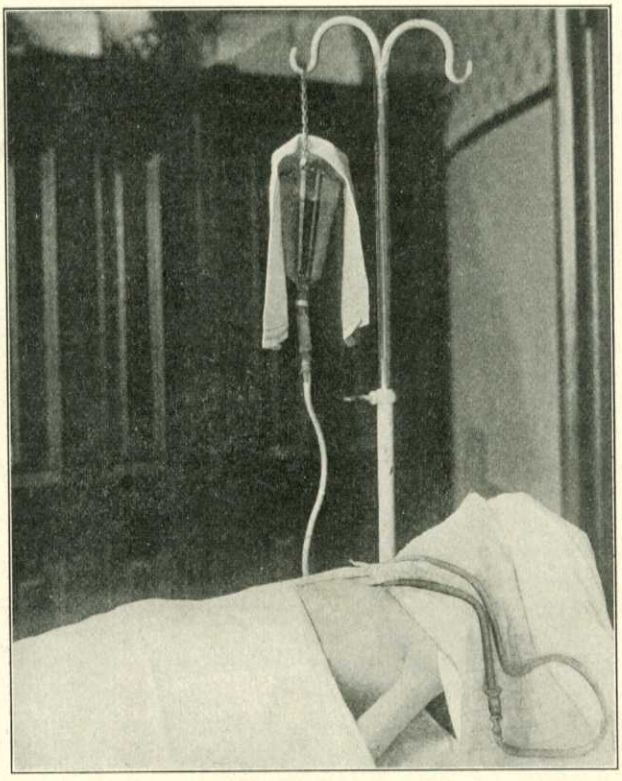

Fig. 62.—Subcutaneous saline infusion (Senn).

Martin). In hemorrhage recurrent attacks of syncope are met with. In pure shock such attacks do not occur. In concealed hemorrhage the abdomen may exhibit physical signs of a rapidly increasing collection of fluid. Shock and hemorrhage are often associated. The essential characteristic of shock is sudden onset, which separates it distinctly from exhaustion. It arises at a much earlier period after an injury than does fat-embolism.

The Prevention of Shock in Operations.—Examine the patient with care before operating, giving special attention to the condition of the kidneys. The amount of urine passed and the amount of urea it contains should always be determined when possible. The amount of urea should be estimated from

the twenty-four hours' urine. The normal amount of urine in the twenty-four hours is about fifty ounces and the normal amount of urea 2 per cent. Less urea is significant of danger from shock and subsequent kidney complications. If the condition of the patient leads us to fear that there will be dangerous shock, do not purge him severely before operation, and just previous to operation give a rectal injection of hot saline fluid. It is a good plan in such cases to give a hypodermatic injection of gr. ⅛ of morphin twenty minutes before operation. Give as little ether as possible. Cover every part but the field of operation with hot blankets and put cans of hot water about the patient, or put him on a bed composed of hot-water pipes covered with blankets. Prevent bleeding with the greatest possible care. Operate as rapidly as is consistent with safety and thoroughness. Crile has shown that when the nerve-trunks from a part have been anesthetized with cocain there is a complete physiological block to peripheral impressions productive of shock. Operations such as amputations can thus be done without depression of the vital powers. Such a method should be used in certain cases in which shock exists or in which we greatly fear its development.

Treatment.—In treating ordinary apathetic shock raise the feet and lower the head, unless this position causes cyanosis. At least place the head flat and the body recumbent. Wrap the patient in hot blankets and surround him with hot bottles, hot bricks, hot-water bags, or cans of hot water. Always wrap a can, a bottle, or a bag in flannel, to avoid burning the patient. Ordinary stimulants seem of but little value. The infusion of salt solution into a vein (Fig. 63) does good, but, unfortunately, the benefit is temporary except in cases associated with hemorrhage. Salt solution may be given by the rectum or subcutaneously. *Hypodermoclysis* is given as follows: Insert an aspirator tube into cellular tissue of the loin, scapular region, or under the mamma, cleansing the part first. The tube is attached to a fountain syringe, which is filled with normal salt solution, and is hung at a height of two or three feet above the bed (Fig. 62). In an hour's time a pint or more of fluid will enter the tissue and be absorbed. It is the custom to give hypodermatic injections of ether, brandy, strychnin, digitalis, or atropin, or inhalations of amyl nitrite. Crile has demonstrated experimentally that strychnin is perfectly futile in pure shock and may actually aggravate the

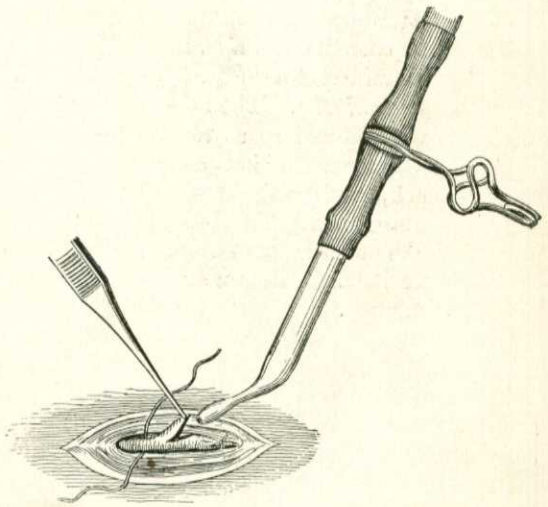

Fig. 63.—Intravenous saline infusion. Manner of incising vein and inserting glass tube (Senn).

condition. In collapse it is of some value. We believe this statement is true clinically. The same experimenter points out that the only way "to increase and sustain the blood-pressure when the vasomotor center is exhausted" is to "create a peripheral resistance either by a drug acting on the blood-vessels themselves or by mechanical pressure."* The proper drug to use is adrenalin chlorid. Because of the rapidity with which this drug is oxidized, Crile gives it intravenously and continuously, using a solution of a strength of from 1 in 50,000 to 1 in 100,000 in salt solution. It is given slowly from a buret, "the rate of flow being controlled by a screw-cock attached to the rubber tube." Since the publication of Crile's paper I have used adrenalin chlorid in shock in preference to strychnin, and am satisfied that it is greatly superior to the latter drug. A preparation of a solution of adrenalin chlorid is on the market which can be readily added to salt solution until the proper degree of dilution is obtained. A teaspoonful of this solution contains the drug in the proportion of 1 part to 1000, and this amount should be added to 1 liter of salt solution. If the skin is very moist, atropin is indicated. Senn recommends the hypodermatic injection of sterile camphorated oil, a syringeful every fifteen minutes until reaction begins. Inhalation of oxygen is often of much service, and artificial respiration may be necessary. Opiates are contraindicated in shock. Mustard plasters should be placed over the heart, spine, and shins. The use of hot and stimulating rectal enemata is important. The rectum may absorb fluids when the stomach refuses to do so. Enemata of hot normal salt solution are beneficial (*enteroclysis*). The tube is carried into the sigmoid flexure and the injection is introduced so as to distend the colon. A turpentine enema is useful. An enema of hot coffee and whiskey is valuable. In severe cases of shock, bandage the extremities. Bandaging for the relief of shock is called *autotransfusion*. This procedure enables the body to utilize to the best advantage the small amount of circulating blood, and sends most of it to the brain, where it will maintain the activity of the vital centers and keep up circulation and respiration. For this purpose ordinary muslin bandages may be used, or gauze bandages, or the bandages of Esmarch. Abdominal massage helps drive out the imprisoned blood, and after massage sets free the abdominal blood apply a compress and binder. In serious cases artificial respiration and stimulation of the diaphragm with a galvanic current may be used. If shock comes on during an operation, the operation must be hurried or even stopped, and proper treatment must be instituted at once. The anesthetizer should give very little ether when shock becomes at all evident. Should we operate during shock? We should only do so when death without instant operation is inevitable. We must operate, if it is necessary to do so, to arrest hemorrhage, to relieve strangulated hernia, intestinal obstruction, obstruction of the air-passages, compound fractures of the skull, extravasated urine, or intraperitoneal extravasations from ruptured viscera. If hemorrhage can be temporarily controlled by pressure or a clamp, so much the better, and the permanent arrest can be effected after the reaction from shock. It is not wise, in the author's opinion, to amputate during shock. A tourniquet or Esmarch bandage should be applied, and attempts be made to bring about reaction, and when reaction is obtained the amputa-

*George Crile, in Boston Med. and Surg. Jour., March 5, 1903.

tion should be performed. It is only just to say that some eminent surgeons oppose this rule. Roswell Park says that "shock is often alleviated by the prompt removal of mutilated limbs which, when still adherent to the trunk, seem to perpetuate the condition." The same teacher believes in operating at once upon severe compound fractures.* After every operation keep careful watch upon the amount of urine passed, see to it that the patient takes sufficient fluid, and if the urine becomes scanty put a hot-water bag over the kidneys, give diuretics and hot saline enemata. If the condition is not soon benefited, infuse hot saline fluid into a vein. *Post-operative suppression of urine* is almost invariably fatal. Delayed shock is treated in the same manner as apathetic shock if hemorrhage can be excluded. If hemorrhage is the cause, the bleeding must be arrested. If delirious shock is due to sepsis, the treatment is that of sepsis. If it is a nervous delirium, give morphin and other sedatives. If due to uremia, the treatment is obvious.

Fat-embolism.—(See page 158.)

Fever.—(See Fevers, page 105.)

Treatment of Wounds.—All wounds, other than those made by the surgeon, are regarded as infected. The rules for treating such wounds are: (1) arrest hemorrhage; (2) bring about reaction; (3) remove foreign bodies; (4) asepticize; (5) drain, coaptate the edges, and dress; and (6) secure rest to the part and combat inflammation. Constitutionally, allay pain, secure sleep, maintain the nutrition, and treat inflammatory conditions.

Arrest of Hemorrhage.—To arrest hemorrhage the bleeding point must be controlled by an Esmarch band or digital pressure until ready to be grasped with forceps; it is then caught up and tied with catgut or aseptic silk. Slight hemorrhage ceases spontaneously on exposure of the bleeding point to air, and moderate hemorrhage ceases permanently after the temporary application of a clamp. An injured vessel when not of the smallest size must be ligated, even if it has ceased to bleed. Capillary oozing is checked by hot water and compression. If a large artery is divided in a limb, apply a tourniquet before ligating (see Wounds of Vessels)

Bringing about of Reaction.—(See Shock.)

Removal of Foreign Bodies.—Remove all foreign bodies visible to the eye (splinters, bits of glass, portions of clothing, gun-wadding, grains of dirt, etc.) with forceps and a stream of corrosive sublimate solution, sterile water, or normal salt solution. In a lacerated or contused wound portions of tissue injured beyond repair should be regarded as foreign bodies and be removed with scissors.

Cleaning the Wound.—To clean the wound shave the surrounding area, if it is hairy; scrub the surface about the wound with ethereal soap, green soap, or castile soap, wash with water, scrub with alcohol, and then with corrosive sublimate solution (1 : 1000). An accidental wound is infected, and must be well washed out with an antiseptic solution. A clean wound made by the surgeon need not be irrigated; in fact, irrigation with an antiseptic fluid leads to necrosis of tissues, causes a profuse flow of serum, and necessitates drainage. If clots have gathered in a wound, they must be removed, as their presence will prevent accurate coaptation of the edges. In an infected wound they are washed out with a stream of corrosive

* Park's "Surgery by American Authors."

solution. In a clean wound they are washed out with hot salt solution. If dirt is ground into a wound, as is often seen in crushes, pour sweet oil into the wound, rub it into the tissues, and scrub the wound with ethereal soap. The oil entangles the dirt, and the soap and water remove both oil and dirt. After the rough cleansing irrigate with corrosive sublimate solution. In some cases, especially in bone-injuries, it is necessary to scrape the wound with a curet. If a fissure of the skull is infected, enlarge the fissure with a chisel in order to clean it. In a badly infected wound one of the most valuable agents for use in producing disinfection is pure carbolic acid. After cleaning the wound, it is necessary in certain regions to examine in order to determine if tendons or considerable nerves have been cut. If such structures have been divided, they must be sutured with fine silk, chromic gut, or kangaroo-tendon.

Drainage, Closure, and Dressing.—Superficial wounds require no special drainage, as some wound fluid will find exit between the stitches and the rest will be absorbed. A large or deep wound requires free drainage for at least twenty-four hours by means of a tube, strands of horsehair, silk, or catgut, or bits of iodoform gauze. An infected wound must invariably be drained. Good drainage may, to a considerable extent, compensate for imperfect antisepsis. If capillary drains be employed, apply a moist dressing. Approximate the edges with interrupted sutures of silk or silkworm-gut if the wound is deep and considerable tension is inevitable. Catgut is used for superficial wounds and for those where tension is slight. If there is decided tension, silver wire may be used. In very deep wounds buried sutures must be used. These sutures may consist of absorbable material (kangaroo-tendon or catgut) or unabsorbable material (silver wire). If the wound is infected, dress with warm, moist antiseptic gauze. If it is not infected, dress with dry sterile gauze. The custom once was to cover even dry gauze with a rubber dam to diffuse the fluids, but we now prefer to omit the rubber dam and use plentiful dressings. A dry dressing absorbs wound fluids quickly and is less likely to become infected. Change the dressings in twenty-four hours, or sooner if they become soaked with discharge. Dressings are changed for cause, but not according to scheduled time. They must, of course be changed when they become soaked with wound fluid, and soaking may occur in a few hours, but may not occur for days. As long as the temperature remains normal, the wound free from pain, and the dressing is not wet with discharge, it can be left in place unless removal is necessary to take out a drainage-tube. If pus forms, open the wound at once. Many surgeons sprinkle wounds before approximation and wound surfaces after approximation with a drying-powder. These powders are of great use in infected wounds, but are not necessary in clean wounds. Among the substances employed are salicylic acid, boracic acid, calomel, acetanilid, aristol, iodoform, subiodid of bismuth, and glutol. In large wounds which cannot be approximated it is occasionally advisable to skin-graft by Thiersch's method. A small wound which cannot be sutured is dusted with an antiseptic powder and dressed. A granulating wound is dressed as is a healing ulcer. A sloughing wound is opened, is dusted with iodoform or acetanilid, and is dressed with hot antiseptic fomentations.

Rest.—Severe wounds require the confinement of the patient to bed.

Bandages, splints, etc., are used to secure rest. The methods of combating inflammation have previously been set forth.

Constitutional Treatment.—Bring about reaction from depression, but prevent undue reaction. Feed the patient well, stimulate him if necessary, attend to the bowels and bladder, secure sleep, and allay pain. Watch for complications, namely, inflammation, suppuration, gangrene, tetanus, erysipelas, suppression of urine, and pneumonia. Observe the temperature closely; it may be a danger-signal of urgent importance.

Incised Wounds.—An incised wound is a clean *cut* inflicted by an edged

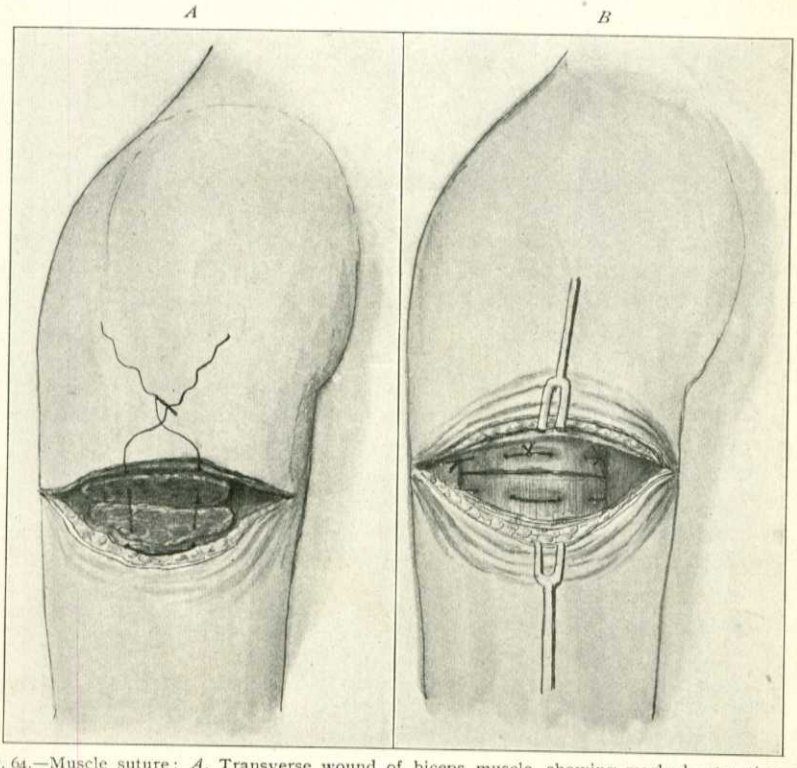

Fig. 64.—Muscle suture: *A*, Transverse wound of biceps muscle, showing marked retraction of muscle-ends and mattress suture in place; *B*, muscle suture completed (Senn).

instrument. Only a thin film of tissue is so devitalized that it must die. These wounds have the best possible chance of union by first intention.

The pain may be very severe; but if the instrument is sharp and used quickly it may be trivial. The pain is less severe than that caused by some other varieties of wounds. The acute pain does not last long, and is followed by smarting. The hemorrhage is profuse, varying, of course, with the region cut. Bleeding from the scalp is violent, because there are numerous vessels which lie in fibrous tissue and cannot retract nor contract. The edges of incised wounds retract because of tissue-elasticity, and the wound "gapes." If the skin or fasciæ are divided at a right angle to the muscle beneath, there is wide gaping. If the cut is parallel to the muscle-fibers, the gaping is slight.

When the skin is violently pulled upon, it tends to split in a certain line. Langer and Kocher speak of this as the line of cleavage, and point out the direction of these lines in various situations. A cut across the line of cleavage

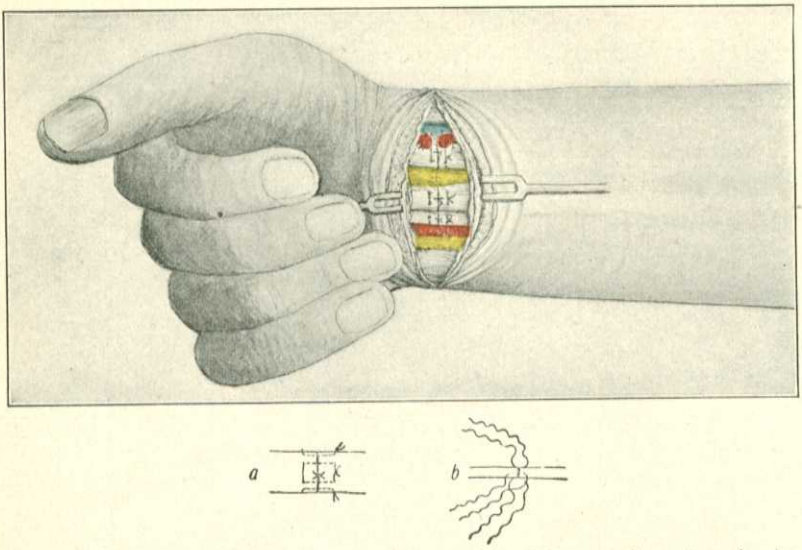

Fig. 65.—Suturing of tendons and nerves in incised wounds: *a*, Primary tendon suture; *b*, primary nerve suture (Senn).

is followed by wide gaping. A cut in the direction of the line of cleavage produces slight gaping, and is followed by a trivial scar.

When a muscle is cut across, the wound edges widely separate. When a tendon is completely cut across, extensive separation occurs.

An incised wound can be thoroughly inspected, all divided structures can be identified, foreign bodies can be easily removed, and disinfection can be satisfactorily carried out.

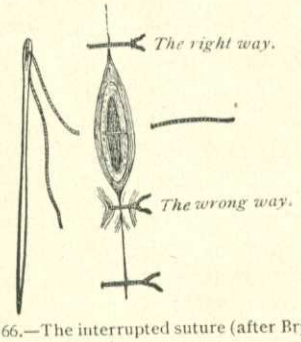

Fig. 66.—The interrupted suture (after Bryant).

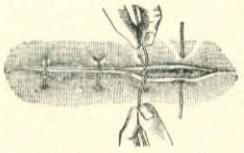

Fig. 67.—Interrupted suture.

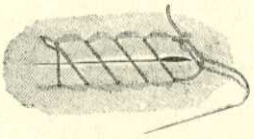

Fig. 68.—Continuous suture.

Treatment.—According to general principles arrest hemorrhage and asepticize.

Examine the wound carefully to see if a nerve, a tendon, or a muscle is divided, and if such injury is discovered, suture at once (Figs. 64, 65).

If the wound is extensive or deep, it may be necessary to use buried sutures in order to keep the sides of the wound in contact. If the surface of a wound is approximated, but the depths are not, the dead space or cavity becomes filled with fluid, and infection almost certainly occurs. If buried sutures have not been used, such a cavity must be obliterated by the judicious application of pressure upon the surface. This is secured by the adaptation of a mass of loose or fluffed-up gauze, and the firm application of a bandage or binder. An incised wound is usually closed with interrupted sutures (Figs. 66 and 67). In adjusting the sutures, see that the edges of the wound are not inverted, but are neatly adjusted, and that the knot does not lie upon the wound line, but rests to the side of it. Tie the stitches firmly but not tightly. If a stitch is tied too tightly it will make a furrow, as shown in Fig. 66, and undue tightness is

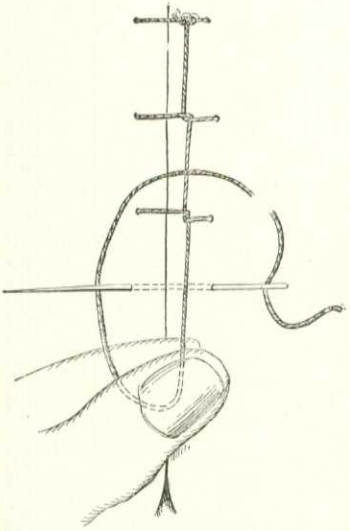

Fig. 69.—Ford's suture: a square knot, a single knot, a double or friction knot, and the first method of passing the needle to tie a single knot immediately.

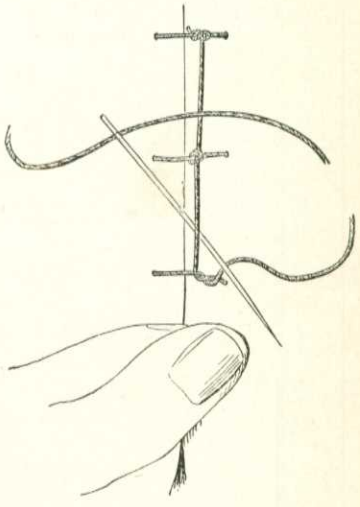

Fig. 70.—Ford's suture: showing two square knots, a single knot, and the method of completing a square knot.

sure to cause necrosis, and is often productive of a stitch-abscess. A silk suture and a catgut suture should be tied with the reef knot; a suture of silkworm-gut should be tied with a surgeon's knot. If a wound is on the face, particular care must be employed in closing it, in order to limit the amount of disfigurement. In a clean wound stitches can, as a rule, be removed in from six to eight days. In a large wound one-half the stitches are removed at one sitting, and in a day or two the rest are removed. Stitches are promptly removed if they begin to cut out or if infection occurs.

The old continued suture (Fig. 68) is rarely used for skin-wounds at the present time. This suture is employed to suture the dura after division, to suture the two layers of pleura together before an abscess of the lung is opened, to suture the peritoneum after laparotomy, and to suture the mucous membrane after certain operations upon the stomach. The continued suture is

shown in Fig. 68. A continuous suture knotted after each emergence was devised by Ford. It is very useful in suturing the parietal peritoneum (Figs. 69, 70).

Halsted's subcuticular stitch (Fig. 71) makes a most perfect closure of the skin-wound, and is followed by the smallest possible scar. It is only used in wounds which are almost certainly clean, as those made by the surgeon, and in wounds which do not require drainage. The suture material should be of silver wire caught upon a curved Hagedorn needle or silkworm-gut carried by a long, straight, round needle. The suture is passed through the corium on each side of the wound, as shown in Fig. 71.

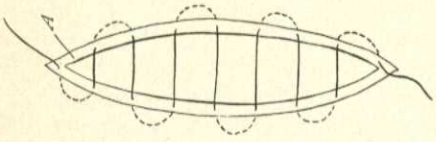

Fig. 71.—Halsted's subcuticular suture. *A* is the true skin.

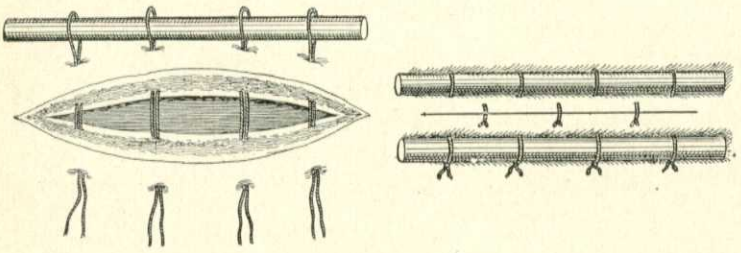

Fig. 72.—The quilled suture.

The curved needle must be held in the bite of a needle-holder. When the suture has been passed the ends are pulled upon, and the skin-wound closes neatly.

Halsted's suture does not penetrate the cuticle; hence, in passing it the white staphylococcus is not carried through stitch-holes and into the wound, an accident which might be followed by infection of a stitch-hole or even of the wound. When it is desired to withdraw this suture, take one end in the bite of a forceps, cut it off short with scissors, and pull steadily upon the other end.

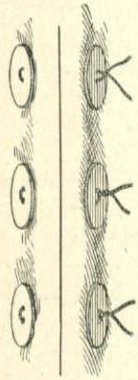

Fig. 73.—Button suture.

In very deep wounds or wounds in which there is much tension after approximation the quilled suture (Fig. 72) or the button suture (Fig. 73) may be used. The twisted suture, or harelip suture, is shown in Fig. 74.

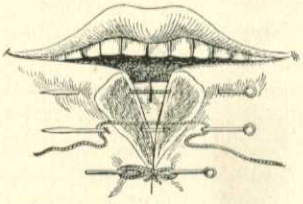

Fig. 74.—The twisted suture.

Problems of drainage, dressing, etc., are discussed on page 198.

If infection occurs, the wound becomes swollen, tender, painful, and discolored, and the temperature of the patient soon becomes elevated. In such a condition cut the stitches, disinfect, and drain.

Wounds of Mucous Membranes.—If the surgeon intends to inflict a wound upon a mucous surface, he should see to it that the patient's general condition is good. Thorough asepsis is impossible, and a good result depends largely upon the vital resistance of the tissues. Before operating, irrigate the part frequently with boric acid, peroxid of hydrogen, or normal salt solution. When ready to sew up the wound be sure that all irritant fluids are removed (saliva in the mouth, etc.). Cleanse the wound with hot normal salt solution. The stitches must include submucous tissue as well as the mucous membrane, and consist of silver wire, silk, chromic catgut, or silkworm-gut. After sewing up a wound in the mouth, wash the cavity at frequent intervals with salt solution, and follow each washing with the insufflation of iodoform.

In accidental wounds irrigate with salt solution, dust with iodoform, and close as directed above. Corrosive sublimate is so irritant that it does harm when applied to a mucous membrane.

Contused and Lacerated Wounds.—A contused wound results from a blow or a squeeze which bruises and crushes the tissues and splits or ruptures the skin. It is a common injury when force is applied to tissues over a bone. The blow of a blackjack may cause either a contusion or a contused wound of the scalp. A contused wound is irregular in outline, with jagged edges, and is surrounded by a broad zone of contusion. The worst form of contused wound is a crush of an extremity produced by being run over. The skin is often widely separated from the tissues beneath.

A lacerated wound results from tearing apart of the tissues. It too is irregular and jagged, and is accompanied by more or less contusion. A *brush-burn* is a contused-lacerated wound due to friction. Both lacerated and contused wounds contain masses of partly detached and damaged tissue, the vitality of which is endangered. Hence, such wounds are apt to slough, frequently suppurate, and are occasionally followed by cellulitis or even by gangrene. There is more danger of tetanus than in incised wounds. A wound especially apt to be followed by tetanus is made by the toy pistol. Nerve trunks, muscles, and great vessels may be torn across. In contused and lacerated wounds the edges are discolored and cold to the touch, and there is little primary hemorrhage unless a cerebral sinus is opened. There is considerable danger of secondary hemorrhage if large vessels have been bruised. In wounds of this nature the pain is often slight, but it may be violent. Shock is very severe.

Avulsion of a limb is a dreadful form of lacerated wound. The thumb or a finger may be torn off or the arm may be wrenched from the body with or without the scapula. In such cases the wound is large, jagged, and irregular, long strings of muscle or tendon hang from the gap, the wound edges are cold, but the bleeding is trivial. The shock is, of course, profound.

Avulsion of the scalp may be produced when the hair is caught in machinery. The American Indian inflicts this injury when he scalps a conquered foe. In some cases of avulsion of the scalp the periosteum is removed with the flap; in most it is not. The flap consists of skin and aponeurosis. In this form of laceration there is severe bleeding.

Treatment.—The surgeon brings about reaction and endeavors to asepticize the wound and skin about it (page 197), arrests hemorrhage, and ligates any visible damaged vessel whether it bleeds or not. Hopelessly damaged tissue

should be cut away, doubtful tissue being retained. In some cases amputation is necessary. Secure thorough drainage, in some situations making counter-openings if necessary. Tube-drainage may be necessary or iodoform gauze packing may be used. Contused wounds and lacerated wounds are rarely closed by sutures except when on the face. They are rarely closed because the damage is so great and the blood-supply so interfered with that primary union will not occur. In the face the blood-supply is so good that primary union may be obtained in part or entirely, and it is worth while to try to obtain it. Cold must not be applied to a region of lowered vitality, because it might cause gangrene. Heat is useful. Hence, it is advisable, even from the start, to dress with hot antiseptic fomentations, and this mode of dressing becomes imperative if sloughing begins. Of course the part must be kept at rest.

If suppuration occurs, the surgeon sees to it that the pus has free exit, and if necessary secures free exit by making incisions.

After avulsion of a limb the patient is reacted from shock, large vessels are sought for and tied, damaged tissue is cut away, the wound is packed with gauze and is *partly* approximated by sutures. After avulsion of the scalp bleeding vessels are carefully ligated. A portion of the scalp may be torn away, but a pedicle may connect it with the balance of this structure. In such a case cleanse it thoroughly and suture it in place (W. T. Bivings, "Phila. Med. Jour.," June 7, 1902). If the portion of scalp is entirely separated, adopt Gussenbauer's suggestion when possible and graft pieces of the avulsed scalp. In any case the ulcer resulting from avulsion must be repeatedly grafted. Abbe in a case obtained healing after four years by the use of 12,000 grafts.

Punctured Wounds.—Punctured wounds are made with pointed instruments, as needles, splinters, etc. The depth of a punctured wound greatly exceeds its surface area. After the withdrawal of the instrument inflicting the injury the wound partly closes at points, blood and wound fluid cannot find exit, and if, as is probably the case, bacteria were deposited in the tissues, infection with pus organisms is very likely to occur, and if it does occur suppuration spreads widely. There is also danger of infection with tetanus bacilli. Such a wound may involve an important blood-vessel, and in such a case profuse hemorrhage may occur; otherwise hemorrhage is slight. A great cavity of the body may be penetrated or an important organ may be wounded. Large-sized foreign bodies may be driven into the tissues or a portion of the instrument may break off and lodge. Pain is rarely severe unless a considerable nerve has been damaged. If both a large vein and artery are punctured, varicose aneurysm or aneurysmal varix may arise.

Treatment.—When possible, inspect the instrument which did the damage, to see if a piece has been broken off. If there is severe hemorrhage, enlarge the wound and tie the bleeding vessels. In a puncture not made by the surgeon, the wound must be regarded as infected. If a wound is made by a dirty instrument through skin known to be unclean, it is proper that the skin about it be sterilized, that the wound be enlarged, that foreign bodies be removed, that the wound be irrigated with an antiseptic solution, or be painted with pure carbolic acid, and be drained with a tube or a strip of gauze. Such treatment, though painful, and appearing unnecessarily severe or even cruel to the sufferer from a trivial puncture, is necessary, and may save the patient from

serious illness or from death. Every deep puncture inflicted by an instrument not surgically clean, and every puncture inflicted by a nail, a splinter, a meat hook, a rusty pin, a tooth of a cat or dog, etc., must be regarded as grossly infected and must be treated by incision, sterilization, drainage, hot antiseptic fomentations, and rest. If the puncture is superficial and is made with a smooth pointed instrument like a needle, when the instrument was not grossly infected the parts may be dressed with hot antiseptic fomentations, but they should be inspected daily for evidence of infection and at the first sign of trouble an incision must be made. If a foreign body is retained in the tissue, it must be removed.

Pure carbolic acid is a most efficient agent to sterilize a punctured wound.

If an important cavity of the body has been invaded by a puncture, exploratory incision is necessary (see Brain, Thorax, Abdomen).

Stab-wounds.—Stab-wounds were formerly considered with punctured wounds, but Senn wisely places them in a class by themselves ("Practical Surgery," p. 150). Stab-wounds are inflicted by penetrating the tissues with a pointed or narrow instrument—for instance, a dagger, a knife, the blades of scissors, a bayonet, or a sword. Such wounds are narrow and very deep. A stab wound may cause rapid death by penetration of a large blood-vessel. Some great cavity of the body may be penetrated and internal hemorrhage will then occur. The body may be transfixed by a sword or bayonet. Bone is rarely injured unless the skull is perforated or the chest entered. In stab-wounds there is usually great hemorrhage and shock.

Treatment.—Whenever possible, look at the instrument which did the damage and see if a piece is broken off. If no great cavity is entered, treat by general rules: arrest bleeding, react from shock, etc. The treatment of penetrating wounds of the abdomen, throat, and cranium is discussed in the special sections

Gunshot-wounds.—Gunshot-wounds are contused or contused-lacerated wounds inflicted by materials projected by explosives. A bit of rock or a crowbar hurled by dynamite inflicts a gunshot-wound, as does a shell-fragment, a pistol-ball, a small birdshot, a rifle-bullet, a flying cap, a piece of wadding, grains of powder, a buckshot, a fragment of metal broken off a shell, grapeshot and canister, or a cannon-ball. Injuries by shell-fragments, portions of a bursted boiler, pieces of masonry or wood, are either lacerated or punctured wounds, and need no special consideration here. In this article we treat of injuries caused by bullets and shot.

The round bullet of the old-time musket being large, moving with comparative slowness, and flattening easily, is very apt to lodge. When it is fired from close range and strikes the tissue at a right angle it produces a "punched-out" entrance wound. If the velocity is low or the impact is not at a right angle to the tissues, the entrance wound may "be formed of triangular flaps," the corners of which are inverted.* The entrance wound is surrounded by a bruised area. The track of the bullet is larger than the bullet, is so badly contused and lacerated that much tissue is devitalized, and the shaft of a bone is apt to be splintered if struck. If the ball emerges, the wound of exit is larger than the bullet and forms triangular and everted flaps (Stevenson). Healing by first intention will rarely occur.

* "Wounds in War," by Surg.-Colonel W. F. Stevenson.

The conical or cylindrico-conoidal rifle-bullet has much greater velocity and penetrating power than the round bullet, hence it is more apt to perforate. The track of this bullet is less devitalized than is the track of the round ball and the surface is not so much contused. The wound of entrance is smaller than the bullet and is punched out or inverted. The wound of exit is larger than that of entrance, and is often everted. The bones are more seriously comminuted than by the round ball, and the fragments may be driven widely into the tissues (Stevenson); in fact, an explosive effect may occur at close range. Delorme lays it down as a rule that comminution of bone makes the wound of exit larger, and he asserts that a wound of exit larger in diameter than the thumb means that there is comminution of bone.

At the present day the old round ball is very rarely used, the conical projectile having taken its place. For the firearms of civilians, as a rule, the bullets are made of lead, hardened and shaped by compression, or hardened by an admixture with tin. The conical shape of the pistol-ball, the great velocity with which it is propelled and with which it rotates, and its hardness make it unlikely that at near range the bullet will only contuse and not enter the skin. It will almost always enter; it will often lodge and will not unusually perforate; it is rarely deflected, and is not nearly so much flattened by impact as is the softer round ball. A pistol-ball or a spent rifle-ball, however, may fail to enter the tissues, grazing the surface and inflicting a brush-burn, or simply contusing the part. A bullet may enter the tissues, a cavity, or an organ, and lodge there, causing a penetrating wound. It may enter and emerge, causing a perforating wound. The bullet may not enter alone, but may carry with it bits of clothing or other foreign bodies. This complication is much more rare in injury by the conical bullet than by the round ball.

The military surgeon deals with wounds inflicted by small, densely hard, conical projectiles, which are impelled at a great velocity and are carried to long distances. A rifle whose caliber is less than 0.35 inch is known as a small-caliber rifle. The best known modern rifles are the Lee-Metford, Krag-Jorgensen, Mauser, Männlicher, Lebel, and Schmidt-Rubin.

The old Springfield rifle, of a caliber of 0.45 inch, projected a bullet with a velocity of thirteen hundred feet in a second.

The Männlicher rifle, of a caliber of 0.25 to 0.32 inch, sends a bullet with a velocity of over two thousand feet a second. This bullet revolves with great velocity upon its own axis (two thousand times the first second) and is effective at several miles.

The bullet of the modern rifle is conical, has a leaden core, and is hardened by being covered with a mantle or jacket of copper, steel, nickel, or of alloys of copper and nickel, or of copper, nickel, and zinc. The hard jacket is absolutely essential, as the speed of the projectile is so great that no soft bullet could take the rifling, fragments would be torn from it in the gun, and the grooves of the barrel would soon fill up with metal, the gun becoming useless.

The Lee-Metford bullet is elongated in outline, has a core of lead hardened with antimony, and the envelope is composed of an alloy of nickel and copper.

The older projectile was apt to lodge; was often deflected in the tissues; was flattened out on meeting with resistant structures, such as bone or cartilage, and after flattening became larger and tore and lacerated the soft parts and comminuted the bone (Fig. 76).

The new projectile is apt to perforate, is rarely deflected, and is so hard that its shape is generally but little altered on meeting with resistant structures, and hence it was thought that the new bullet would prove more humane than the old projectile, and inflict wounds which would be more easily treated, because the bullets would not lodge and because extensive damage would not be inflicted. This view has proved to a great extent correct. In many instances a modern bullet will make a clear track without laceration or comminution. Senn, Nancrede, and other American surgeons in the Spanish-American War say the modern projectile is humane at a range over fifteen hundred yards, as it generally penetrates cleanly, making a wound which heals often by first intention. Sir Frederick Treves says "the Mauser bullet is a very merciful one." In some instances, however, the small bullet pulpefies structure for a considerable distance around the track of the ball by what is known as the explosive effect. This term does not mean that the bullet has exploded, but that its sudden impact against tissues has by waves of force caused extensive and distant damage, and often horrible and irreparable injury. Explosive effects are seen most often at close range, when the velocity of the ball and the fre-

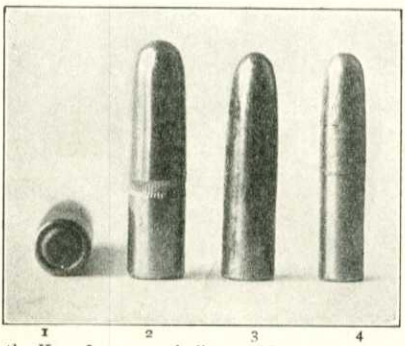

Fig. 75.—1, End view of 2, the Krag-Jorgensen bullet; 3, Mauser bullet; 4, Lee-Metford bullet, used by the United States Navy.

quency of its rotation are most marked. A pistol-ball has no explosive action at all, and the old-time bullet possessed it only at very close range. The modern projectile always produces explosive effects up to five hundred yards. Up to thirteen hundred yards it produces them upon the skull and brain. At this distance a single small projectile may entirely destroy the cranium and brain (see Demosthen's studies of the action of the Männlicher rifle). Explosive effects are noted at longer distances upon the liver, spleen, kidneys, and lungs, and upon hollow viscera containing fluid.

At a distance of five hundred yards or less a bone will be shattered into many fragments. At a range of fifteen hundred or two thousand yards the bone will be cleanly perforated, usually without comminution. It is often extraordinary how little trouble follows a wound and how quickly healing occurs. This is due to the fact that the bullet is sterile when it reaches the tissue, and that foreign bodies are rarely carried in with it. In some observed cases there have been almost no symptoms after perforation of the lungs, in others after perforation of the abdomen or joints or skull. It is obvious that the humanity of the modern rifle is largely a matter of range. At a range of fifteen hundred yards or more it is a humane weapon.

The wound of entrance is extremely small, and could be overlooked by a careless observer. It is usually circular, but may be triangular. The wound of exit is also small, and may be round or may be a slit. If the injury was inflicted at close range, the wound of exit is large. This projectile theoretically does not flatten, but practically in many instances it does flatten a little, and in others its coat is torn off when it strikes hard bone at a distance of less than eighteen hundred yards (Fig. 77). Treves points out that if the bullet smashes a bone and lodges, the shell peels off from the core as a rule, and the bullet may be distorted or even broken into fragments. The bullet may lodge at long range, or if it hits a man after bounding from a stone. In Cuba 10 per cent. of the wounded suffered from lodged bullets. The old-style bullet rarely causes much primary hemorrhage, as the vessels as well as the nerves and tendons are usually pushed aside rather than cut. Hence secondary hemorrhage is common because of contusion of the vessel-walls. The modern bullet

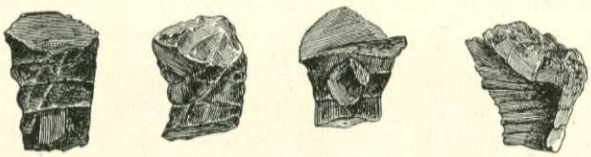

Fig. 76.—Deformation of leaden bullets (natural size) (Seydel).

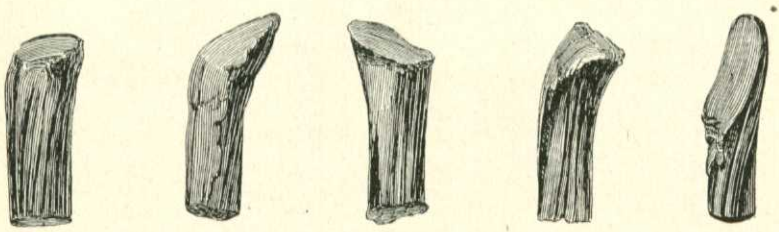

Fig. 77.—Deformation of small-caliber jacketed bullets (after Bruns).

cuts rather than pushes aside the vessels. Hence primary hemorrhage is profuse if a large vessel is struck, and may prove fatal. The modern bullet rarely lodges and is rarely deflected. Skin is usually split by it. Fascia and muscle are usually much damaged, but in a transverse wound of muscle the fibers may be separated rather than destroyed (Conner). The effects of the modern bullet have been determined by careful study and experiment; by an investigation of the wounds in the Chitral Expedition and of wounds inflicted by accident or with homicidal or suicidal intent; by experiments: firing through boxes filled with wet sand; firing into thick oak; firing at cadavers at fixed distances with reduced charges (La Garde); firing at corpses and at live horses with service-charges (Demosthen). Nancrede cautions us to remember that experiments upon the cadaver, employing reduced charges and standing at fixed distances, are uncertain in their provings. "The difference between the velocity of rotation and angle of incidence with reduced charges at fixed distances and service-charges at actual distances is marked. The tension of living muscles and fasciæ, as compared with dead tissues, and the physical

change of the semi-liquid fat of adipose tissue and medulla to a more solid condition by the loss of animal heat, influence the results." *

All theoretical conclusions have been put to the test in the Spanish-American War and the South African War, and preconceived opinions have to a great extent been confirmed. The effect of the bullet at close range was observed in the marines killed at Guantanamo, in persons killed during the Milan riots, and in many instances in South Africa.

It has been found that the modern small-caliber bullet, unless it strikes a vital part or a large bone, lacks "stopping power," and in warfare with savages the bullet must have stopping power, or the wounded man will continue to fight and charge. Civilized men will usually stop when hit, savages often will not; hence, in warfare with barbarous people the ordinary bullet must be modified. In the Dumdum bullet a portion of lead at the apex of the projectile is left uncovered, and the bullet when it strikes spreads out—mushrooms, as it is called—and inflicts an extensive wound which "stops" the most ferocious and fanatical. German surgeons denounce such bullets as inhumane, but Stevenson and other English surgeons say that the Dumdum bullet is more humane than the Snider or Martini-Henry. The name Dumdum comes from the ordnance factory, near Calcutta, where bullets of this character were first made.

Wounds by Cannon-balls.—A cannon-ball weighing five or six pounds may be imbedded in tissues. A ball or shell-fragments may tear off a limb or lacerate it extensively. In some cases of injury by spent balls the bone is destroyed and the muscles disorganized while the skin is intact.

Wounds by Small Shot.—The degree of injury is in direct ratio to the nearness of the individual to the gun when the discharge took place, to the size and number of the shot, and to the charge of powder. Single shot may bruise the surface or may enter the tissues. When many shot enter together they strike as a solid body. Single shot are usually deflected from vessels and nerves, and rarely lodge in bone, but rather flatten on its surface. Numerous shot entering together at close range produce extensive burns and fearful lacerations and inflict damage which is often irreparable. Pieces of clothing or other foreign bodies may be carried into the wound with the shot.

Blank Cartridge Injuries.—These injuries only occur at close range. They consist of burns and lacerations and frequently a wad is lodged in the tissues. Tetanus is liable to follow these injuries.

Symptoms of a Gunshot-wound.—Hemorrhage is often considerable, but ceases spontaneously unless a large vessel has been divided. If hemorrhage is profuse, the constitutional symptoms of hemorrhage exist. These symptoms are of great importance in abdominal wounds. A pistol-ball

* Nancrede upon "Gunshot Wounds," in Park's "Surgery by American Authors" For information upon wounds by the modern firearm, see recent reports of Surgeon-General of the United States Army; Demosthen's study of the wounds inflicted by the Männlicher rifle; Prof. Conner, in Dennis's "System of Surgery;" Forwood, in "The International Text-Book of Surgery;" the elder Senn in "Medico-Surgical Aspects of the Spanish-American War;" Sir Frederick Treves in the Lancet, May 12, 1900; Discussion in the British Medical Association, 1899; reports of Mr. G. H. Makins and Clinton T. Dent; Francis G. Abbott on the "Surgery of the Græco-Turkish War," in Lancet, Jan. 14, 1899; editorial in Boston Med. and Surg. Jour., May 4 and May 9, 1899; a study of "Gunshot Injuries by the Rifles of Reduced Calibre," by Louis A. La Garde, in Boston Med. and Surg. Jour., Nov. 1, 1900; J. Lynn Thomas in Lancet, Nov. 3, 1900.

rarely causes severe primary hemorrhage, because it will not often penetrate a large artery. It is apt to push aside a vessel, and secondary hemorrhage is not unusual. Even if a large vessel is wounded and a succession of violent hemorrhages occur, a man may live for several days. Secondary hemorrhage may follow a gunshot-wound because of contusion of vessels or of infection.

Pain is often not noticed at first, especially if the injured individual was greatly preoccupied or excited. There may be a feeling of numbness, but there is usually a dull or stinging pain. If a large nerve is injured, there may be violent pain. Even trivial gunshot-wounds frequently produce profound shock, and yet it may happen that severe wounds may be accompanied by but slight shock. In most gunshot-wounds of the brain, abdomen, and spinal cord the shock is very great.

General Considerations as to Treatment.—The dangers are shock, hemorrhage, and infection. Bullets are aseptic when they enter a part, and if infection is not inserted in the track of the ball the wound will in most in-

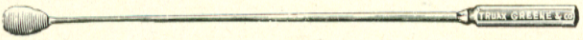

Fig. 78.—Nélaton's bullet probe.

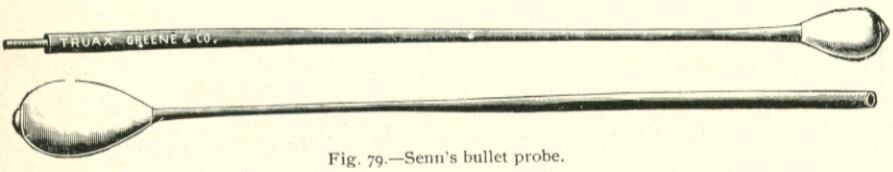

Fig. 79.—Senn's bullet probe.

Fig. 80.—Fluhrer's aluminum gravitation probe (natural size, except the length, which is twelve inches).

stances heal kindly. "The fate of a wounded man is in the hands of the surgeon who first attends him" (Nussbaum). The danger of a wound depends upon the size and velocity of the bullet, the part struck, "and the degree of asepsis observed during the first examination and dressing" (Nancrede). The rules of treatment are: bring about reaction, arrest hemorrhage, preserve asepsis, and, in some cases, remove the ball. Always notice if a wound of exit exists. It is a good plan, when endeavoring to determine the extent of injury, to put the parts in the position they were in when the injury was inflicted. We should try to ascertain the size and nature of the weapon, and the range at which it was fired. Examine the clothing to see if any fragments are missing and could have been carried in. Such fragments render sepsis almost inevitable. The surgeon must not feel it his duty to probe in all cases. In many cases it is better not to probe at all. Explore for the ball when sure that it has carried with it foreign bodies; when its presence at the point of lodgment interferes with repair; when it is in or near a vital region (as the brain); and when it is necessary to know the position of the bullet in order to determine the question of amputation or resection. If the wound is large enough, the finger is the best probe.

Fluhrer's aluminum probe is a valuable instrument (Fig. 80). It is employed especially in brain-wounds, and is allowed to sink into the track of the ball by the influence of gravity after the part has been placed in a proper position. If a lead bullet is deeply imbedded, it is possible to distinguish the hard projectile from a bone by inserting the asepticized stem of a clay pipe, a bit of pine wood, or *Nélaton's porcelain-headed probe* (Fig. 78). On any one of these appliances lead will make a black mark. No such test can be applied to a modern bullet, for this has a hard metal jacket, and will not make a black mark on a white substance.

Though Nélaton's probe will not show the difference between a hard projectile and bone, it is a valuable instrument to follow the track of a wound. The porcelain head ought to be larger than it is usually made—in fact, it should be nearly the size of the bullet (Senn) (Fig 79).

In passing a probe use no more force than in passing a catheter (Senn).

The *induction balance* of Graham Bell has been employed to determine the situation of a bullet. The bullet may be located by *Girdner's telephonic probe*. In order to construct this instrument, take a telephone receiver, fasten one of the wires to a metal plate and the other one to a metallic probe. Moisten a portion of the patient's body and place the metal plate in contact with it. The surgeon places the receiver to his ear and inserts the probe into the wound.

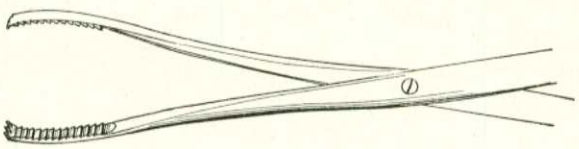

Fig. 81.—Bullet-forceps.

If the probe strikes metal, a click is heard with distinctness. A bullet may be located by *Lilienthal's probe*. This apparatus consists of a mouth-piece, two insulated copper wires, and a probe. The mouth-piece is composed of two plates, one of copper and one of zinc, which are applied to the sides of the tongue. An insulated wire runs from each plate and into the metal probe. The tip of the probe is composed of two or four pieces of metal, is separated from the shank by a washer of rubber, and is attached to the wires. The operator closes the teeth upon the mouth-piece, and inserts the probe into the wound. If the probe touches the bullet, a distinct and continuous metallic taste is appreciable.

The best means of discovering a bullet is to use the *fluoroscope* or take a *skiagraph*. In order to locate it accurately, view it through a series of squares, insert guide-pins, or, better than either of these plans, employ Sweet's apparatus. Bullets are readily seen by the fluoroscope in the superficial soft parts, and are discovered in deeper structures (bone, abdomen, lung, brain, etc.) by taking skiagraphs.

In extracting the ball use very strong forceps (Fig. 81). The old American bullet-forceps is useless for the extraction of the hard-jacketed ball, as the points will not penetrate and the instrument will not hold.

If hemorrhage is severe in a gunshot-wound, enlarge the wound, find the bleeding vessel, and tie it. Before handling a gunshot-wound asepticize the

parts about it and irrigate the wound with hot sterile salt solution. In some situations a wound should be drained with a short tube or a bit of iodoform gauze; in other regions this is unnecessary. The dressing should be antiseptic. Primary union rarely takes place after a wound inflicted by a pistol-ball or an ordinary rifle-ball, because of the inevitable necrosis of damaged tissue in the track of the ball, but in some cases it can be obtained. Primary union is frequent after injury by the small hard-jacketed modern projectile. Healing begins in the depths of the wound and extends toward the wound of entrance, or, if there be also a wound of exit, toward both. Radical operations may be demanded: laparotomy, trephining, rib-resection, joint-resection, and amputation.

Amputation is sometimes demanded because of great injury to the soft parts (as by a shell-fragment), the splintering of a bone, injury of a joint, damage to the chief vessels or nerves, or the destruction of a considerable part of a limb. Perform a primary amputation if possible, and make the flaps through tissue that will not slough. In civil practice, with careful antisepsis, more questionable tissue can be admitted into a flap than in military practice, where transportation will become necessary and antisepsis may be imperfect

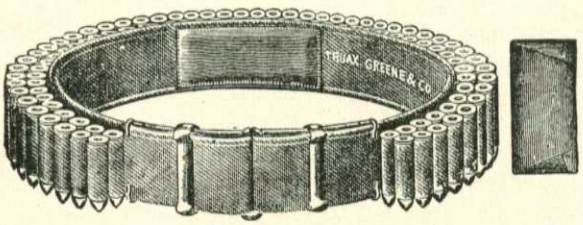

Fig. 82.—Cartridge belt with first-aid package sewed on inner surface.

or wanting. It has been shown in recent years that even when a large joint has been perforated by a small hard-jacketed projectile, amputation or resection is rarely required if the wound was treated aseptically from the beginning.

Prevention of infection in wounds inflicted in war is of great importance. In warfare at the present day an attempt is made to limit the death-rate from gunshot-wounds by protecting them from infection at an early period after the accident. Esmarch offered a suggestion, which has been adopted in the armies of all civilized countries. Every soldier carries a package which contains antiseptic dressings, and at the first opportunity after the infliction of a wound, if possible on the field, these dressings are applied by the soldier or by a comrade (for even the privates are instructed in the application), or by an ambulance man. If not applied on the field, they are applied at the first dressing-station by a surgeon or a hospital steward. Senn considers Esmarch's package too cumbrous.* He suggests a package containing half an ounce of compressed salicylated cotton. In the center of this cotton is an antiseptic powder (2 gm. of boric acid and 0.5 gm. of salicylic acid). The cotton is wrapped in a triangular gauze bandage. A safety-pin is placed in the bandage and the entire bundle is wrapped in gutta-percha tissue (Fig. 82). Senn says

* Jour. Am. Med. Assoc., July 13, 1895.

the triangular bandage is sufficient to hold a dressing in place, and it can be assisted by utilizing the gunstrap, safety-belt, or articles of clothing.* (For gunshot-wounds of special structures, see Bones, Joints, Abdomen, Brain, etc.) When a wound has been inflicted by a *blank cartridge*, the surface should be sterilized, the wound irrigated, foreign bodies removed, the parts sterilized, and dressed with hot antiseptic fomentations. In some cases the wound should be enlarged; in some, powder grains should be removed from the skin. In view of the danger of lockjaw and because tetanus bacilli do not multiply when exposed to oxygen, some surgeons advocate keeping such wounds exposed to the air throughout the treatment. After an injury with *shot*, bleeding should be arrested, the parts should be cleansed, bits of clothing and other such foreign bodies should be removed, and antiseptic dressings should be applied. It is not necessary to remove the shot unless they are doing harm or unless they lie just beneath the skin.

Poisoned wounds are those into which some injurious substance, chemical or bacterial, was introduced. This poison may be microbic and capable of self-multiplication, or it may be chemical, and hence incapable of multiplication. There are three classes of poisons: † (1) mixed infection, as septic wounds, dissection-wounds, and malignant edema; (2) chemical poison, such as snake-bites and insect-stings; and (3) infection with such diseases as rabies, glanders, etc.

Septic wounds are those which putrefy, suppurate, or slough. Septic wounds should be opened freely to secure drainage, and hopelessly damaged tissue should be curetted or cut away. The wound should be washed with peroxid of hydrogen and then with corrosive sublimate, dusted with iodoform or orthoform, either drained with a tube or packed with iodoform gauze, and dressed with hot antiseptic fomentations. The part must be kept at rest and internal treatment should be stimulating and supporting. If lymphangitis arises, the skin over the inflamed vessels and glands is to be painted with iodin and smeared with ichthyol, and quinin, iron, and whiskey are given internally. The temperature is watched for evidence of general infection or intoxication. The patient must be stimulated freely, nourishing food is given at frequent intervals, pain is allayed by anodynes if necessary, and sleep is secured.

Dissection-wounds are simple examples of infected wounds, and they present nothing peculiar except virulence. They affect butchers, cooks, surgeons who cut themselves while operating on infected areas, those who make post-mortems, and those who dissect. A dissection-wound inflicted while working on a body injected with chlorid of zinc possesses but few elements of danger unless the health of the student is much broken down. If a wound is simply poisoned with putrefactive organisms, there is rarely serious trouble. Post-mortems are peculiarly dangerous when the subject has died of some septic process. When a wound is inflicted while dissecting, wash it under a strong stream of water, squeeze, and suck it to make the blood run, lay it open if it be a puncture, paint it with pure carbolic acid, and dress it with iodoform and hot antiseptic fomentations. Trouble, of course, may follow, but often it is only local, and a small abscess forms. It should be treated by hot antiseptic fomentations and early incision. Occasionally

* Senn, in Jour. Am. Med. Assoc., July 13, 1895.
† "American Text-book of Surgery."

lymphangitis arises, adjacent glands inflame, and constitutional symptoms arise. It is rarely that true septicemia or pyemia arises unless the wound was inflicted while making a post-mortem upon a person dead of septicemia or while operating on a septic focus. If glands enlarge and soften, it may be necessary to remove them surgically.

Malignant edema or **gangrenous emphysema** arises most commonly after a puncture. It is due to a specific bacillus which produces great edema. The emphysema which soon arises is due to mixed infection with putrefactive organisms. Pus does not form, but gangrene occurs. The disease is identical with one form of traumatic spreading gangrene (page 144).

Symptoms.—The symptoms are identical with those of traumatic spreading gangrene with emphysema.

There is a rapidly spreading edema, followed by gaseous distention of the tissues and by gangrenous cellulitis. The zone of edema is at the margin of the emphysema, and the process spreads rapidly. The emphysematous zone crackles when pressed upon. The area of edema is covered with blebs which contain thin, putrid, reddish matter, and the skin becomes mottled. If a wound exists, the discharge will be bloody and foul. If incisions are made, a thin, brown, offensive liquid flows out. High fever rapidly develops, the patient becomes delirious, and often coma arises. In most cases death ensues in from twenty-four to forty-eight hours.

Treatment.—If malignant edema affects a limb, amputate at once, high up. If it affects some other part, make free incisions, employ hot, continuous antiseptic irrigations or the hot antiseptic bath, and stimulate freely (page 49).

Stings and Bites of Insects and Reptiles: Stings of Bees and Wasps.—A bee's sting consists of two long lances within a sheath with which a poison-bag is connected. The wound is made first by the sheath, the poison then passes in, and the two barbed or twisted lances, moving up and down, deepen the cut. The barbs on the lances make it difficult to rapidly withdraw the sting, which may be broken off and remain in the flesh. Besides bees, hornets, yellow jackets, and other wasps produce painful stings. The sting of a wasp is rarely broken off in the tissues because the beards on the darts are shorter and hence the sting is not so firmly fixed in the flesh, and also because these insects are more rapid and nimble in their actions. Stings of bees and wasps rarely cause any trouble except pain and swelling. In some unusual cases a bee-sting is fatal; persons have been stung to death by a great number of these insects.

Symptoms.—If general symptoms ensue, they appear rapidly, and consist of great prostration, vomiting, purging, and delirium or unconsciousness. These symptoms may disappear in a short time, or they may end in death from heart-failure. Stings of the mouth may cause edema of the glottis.

Treatment.—To treat a bee-sting, extract the sting with splinter forceps if it has been broken off and is visible in the wound. If it is not visible, squeeze the part lightly in order to expel it, or at least expel the poison. Pressure may be most satisfactorily made by means of the barrel of a key. The poison is counteracted by touching with ammonia or washing the part in ammonia-water, touching with pure carbolic acid, painting with tincture of iodin, or soaking in a strong solution of common salt or carbonate of sodium.

The part may be dressed with lead-water and laudanum, a solution of washing-soda, or a solution of common salt. If constitutional symptoms appear, stimulate.

Other Insect-bites and Stings.—The mandibles of a *poisonous spider* are terminated by a movable hook which has an opening for the emission of poison. The bite of large spiders is productive of inflammation, swelling, weakness, and even death. The bite of the poisonous spider of New Zealand produces a large white swelling and great prostration; death may ensue, or the victim may remain in a depressed, enfeebled state for weeks or even for months. The *tarantula* is a much-dreaded spider. The scorpion has in its tail a sting. The sting of a *scorpion* produces great prostration, delirium, vomiting, diaphoresis, vertigo, headache, local swelling, and burning pain, followed often by fever and suppuration, and occasionally even by gangrene, but it is rarely fatal. *Centipedes* must be of large size to be formidable to man, and the symptoms arising from their stings are usually only local.

Treatment.—Tie a fillet above the bitten point; make a crucial incision, favor bleeding, and paint the wound with pure carbolic acid or some caustic or antiseptic (if in the wilds, burn with fire or gunpowder); dress antiseptically if possible, and stimulate as constitutional symptoms appear. Slowly loosen the ligature after symptoms disappear. Chloroform stupes and ipecac poultices are recommended; also puncture with a needle and rubbing in a mixture of 3 parts of alcohol and 1 part of camphor (Bauerjie).

Snake-bites.—The poisonous snakes of America comprise the copperheads, water-moccasins, rattlesnakes, and vipers. The cobra of India is a deadly reptile. In some countries great numbers of people and the lower animals are killed by poisonous serpents. In India during 1898, 21,921 persons and at least 80,000 cattle were killed by snakes ("Brit. Med. Jour.," Nov. 25, 1899). The symptoms of snake-bite are similar in kind whether it is the bite of an Indian cobra or of an American rattler, and they depend upon the toxic power and the dose of poison introduced. The symptoms vary in intensity according to the virulence of the poison. The toxic power of the poison varies in different species and also in different members of the same species. Poison injected into a vein may prove almost instantly fatal. The poison is not absorbed by the sound mucous membranes. Poison is harmless when given by the mouth and swallowed, but if directly introduced into the intestine of an animal it is certainly fatal. The pancreatic ferment destroys the toxic power of the venom (R. H. Elliot, in "Brit. Med. Jour.," May 12, 1900). It is discharged through the hollow fangs of the reptile, having been forced out by contractions of the muscles of the poison-bag. In most varieties of snakes the teeth lie along the back of the mouth and are only erected when the reptile strikes. Snake-poison is a thin, greenish-yellow, turbid, sterile fluid, of acid reaction and of a distinctive odor. The poisonous elements are globulins, peptones, and possibly animal alkaloids (Mitchell and Reichert). The two chief poisonous principles are called venom-peptone and venom-globulin (Gustave Langmann, "Medical Record," Sept. 15, 1900).

Symptoms.—Snake-poison produces paralysis of the smaller blood-vessels; edema and inflammation about the bite; destroys the coagulating power of the blood; causes destruction of red corpuscles, exudation of fluid elements, extravasation about the bite and in mucous and serous membranes,

and nervous symptoms of great violence. The symptoms are: pain, soon becoming intense; mottled swelling of the bitten part, which swelling may be enormous, and which is due to edema and extravasation of blood, and assumes a purpuric discoloration. Muscular twitching, convulsions, and finally paralyses are usually noted. There may be complete consciousness, or there may be lethargy, stupor, or coma. The general symptoms are those of profound shock, which may present delirium (delirious shock). Death may be due to paralysis of the heart or paralysis of respiration, and may occur in about five hours, but as a rule it is postponed for a number of hours. If death is deferred for a day or more, profound sepsis comes upon the scene, with glandular enlargement, suppuration, and sometimes gangrene.

Treatment.—Cases of snake-bite must, as a rule, be treated without proper appliances. The elder Gross was accustomed to relate in his lectures how he had seen an army officer blow off his finger with a pistol the moment after it was bitten by a rattlesnake, and thus escape poisoning. In general, the rules are to twist several fillets at different levels above the bite, to excise the bitten area, to suck or cup it if possible, and to cauterize it with a pure acid or by heat. An expedient among hunters is to cauterize by pouring gunpowder on the excised area and applying a spark, or by laying a hot ember on the wound. When a hot iron is available, use it. The fillets are not to be removed suddenly, and they had best be kept on for some time. Remove the highest constricting band first; if no symptoms come on after a time, remove the next, and so on; if symptoms appear, reapply the fillet. The constitutional treatment is expressed in one word: stimulate. Our only hope is in large doses of alcohol, and, if they can be obtained, ammonia, ether, strychnin, or digitalis hypodermatically administered. Large doses of strychnin hypodermatically are used by many surgeons in India. Morphin may be required for pain. There is no specific for snake-poison. Hypodermatic injections of a 1 per cent. solution of the permanganate of potassium in the area adjacent to the bite are commended by some. Others inject in many places about the wound a few drops of a 10 per cent. watery solution of chlorid of calcium. Halford of Australia praises the intravenous injection of ammonia (10 ♏ of strong ammonia in 20 ♏ of water). If a man is bitten by a large and deadly snake, the surgeon, if one is at hand, should at once amputate well above the bite.* Attempts are being made to obtain a curative serum. Animals can be rendered immune by giving them at first small doses of the poison and gradually increasing the amount administered. It is asserted that the serum of immune animals will cure a person bitten by a venomous snake. Cures have been reported after the use of Calmette's antivenene serum. The dose is from 10 c.c. to 20 c.c. hypodermatically, repeated if necessary in three or four hours.

The poisonous lizard (Gila monster) can kill small animals, but it is not believed that its bite would prove fatal to man.

Anthrax (malignant pustule, charbon, wool-sorters' disease, Milzbrand, or splenic fever) is a term used by some as synonymous with ordinary carbuncle, but it is not here so employed. Anthrax, as met with in man, is a disease contracted in some manner from an animal with splenic fever. It may be contracted by working around diseased animals, by handling or tanning their hides or by sorting their hair or wool; it may be conveyed by eating

* Charters James Symonds, in "Heath's Dictionary of Practical Surgery."

infected meat or by drinking infected milk. Flies may carry the poison. Inhalation of poisoned dust may infect the lungs. Catgut ligatures may be contaminated and carry the poison. Many attempts, not altogether satisfactory, have been made to render animals immune (Pasteur, Woolbridge, Hankin). Certain organisms are antagonistic to anthrax (the streptococcus of erysipelas, the pneumococcus, the micrococcus prodigiosus, and the bacillus pyocyaneus). The author has seen two cases of anthrax both of which arose in Philadelphia.

Forms of Anthrax.—There are two forms of the disease—external and internal. Internal anthrax may be intestinal from eating diseased meat or pulmonary from inhalation of poisoned dust. External anthrax may be anthrax carbuncle or anthrax edema. In over 80 per cent. of cases of external anthrax the lesion is on an exposed portion of the body. The local symptoms are usually very trivial at first, but become suddenly worse after a variable period, usually between twelve and forty-eight hours. The *external* form appears in from three to six days after inoculation, and presents an itching, burning papule with a red base; the papule becomes a vesicle which contains bloody serum; the vesicle bursts and dries, the base of it swells and enlarges, other vesicles appear in circles around it, and there is developed an "anthrax carbuncle," which shows a black or purple elevation with a central depression surrounded by one or more rings of vesicles. Pain is trivial. Lymphatic enlargements occur. Within forty-eight hours after the pustule begins micro-organisms usually appear in the blood. In loose connective tissue the lesion may be anthrax edema, a spreading livid edema followed by blebs and even by gangrene. In a case seen by the author in the Philadelphia Hospital the forearm and arm and shoulder were extensively edematous. The constitutional symptoms may rapidly follow the local lesion, but may be deferred for a week or more. The patient feels depressed, has obscure aches and pains, and is feverish, but usually keeps about for a short period. After a time he is apt to develop rigors, high irregular fevers, sweats, acute fugitive pains, diarrhea, delirium, typhoid exhaustion, dyspnea, cough, and cyanosis. The carbuncle of anthrax is distinguished from ordinary carbuncle by the central depression, the adherent eschar, the absence of pain, tenderness, and suppuration of the first, as contrasted with the elevated center, the multiple foci of suppuration and sloughing, and the acute pain of the second. Anthrax edema differs from cellulitis in the absence of all tendency to form pus, and from malignant edema by the greater tendency of the latter to result in gangrene. If anthrax has a visible lesion and the constitutional symptoms are slight or absent, the chance of cure is good.

Treatment.—If a person is wounded by an object suspected of carrying the infection, cauterize the wound with the hot iron. A sufferer from anthrax must be isolated in a well-ventilated room. All dressings are to be burned, all discharges asepticized, and after the removal of the patient the bed-clothes are burned and the room disinfected. A malignant pustule should be entirely excised, and the wound mopped out with pure carbolic acid or burned with the hot iron, and afterward dressed with wet bichlorid of mercury gauze which is covered with an ice-bag. Excision should be practised even when glands are enlarged, but it will prove ineffectual if organisms are present in the blood. When excision cannot be performed make crucial incisions through the lesion,

mop the wounds with pure carbolic acid, and inject about and in the pustule carbolic acid (1 : 10) every six hours until the disease abates or toxic symptoms appear. The adherent eschar is subsequently removed by hot antiseptic fomentations. Davaine advised the following plan: Inject the pustule and the tissues about it at many points every eight or ten hours with 1 part of tincture of iodin diluted with 2 parts of water or with a 10 per cent. solution of carbolic acid, or with a 0.1 per cent. solution of corrosive sublimate. Dress with wet antiseptic gauze and apply an ice-bag. The skin over inflamed lymphatic vessels and glands should be painted with iodin and smeared with ichthyol. Constitutional treatment must be sustaining and stimulating. Maffucci gives carbolic acid internally, and also uses it externally. Davies-Colley uses ipecac locally and gives gr. v by the mouth every four hours. Pulmonary anthrax and intestinal anthrax are always fatal. The treatment is symptomatic.

Hydrophobia, Rabies, or Lyssa.—Hydrophobia is a spasmodic and paralytic disease due to infection through a wound with the virus from a rabid animal. The disease does not appear to arise except as the result of inoculation. The animal may be a dog, a cat, a wolf, a fox, or a horse. It is far more common in the carnivora than the herbivora. It is said that poultry may suffer from it. Roux estimates that about 14 per cent. of the people bitten by mad animals develop the disease. If the bite is on an exposed part, it is far more apt to cause rabies than if the teeth pass through clothing. The saliva is the usual vehicle of contagion, but other fluids and tissues contain the virus, especially the brain and cord. Hydrophobia has been known for centuries. It is mentioned by Aristotle and alluded to by Plutarch. At the present day some ardent antivivisectionists dispute its existence. The fact that an infant bitten by a rabid animal may develop rabies proves that the disease is not due to the imagination. Hydrophobia is almost invariably fatal. No causative bacterium has been demonstrated. The poison cannot gain entrance through sound mucous membrane. It used to be thought that the disease was particularly apt to arise in hot weather, but it is now known that it may occur any time of the year. No constant post-mortem lesions have been certainly demonstrated in those dead of rabies. Gowers believes that in the spinal cord there is hyperemia, but no infiltration with cells, whereas in the medulla, especially about the respiratory center, there are hyperemia and cellular infiltration of the perivascular spaces. But such perivascular infiltration can occur in some other acute conditions and hence is not characteristic. What is known as the rabic tubercle is found in the medulla and about the motor cells of the upper part of the spinal cord. Each tubercle consists of an aggregation of cells. Babes thinks the tubercle characteristic. Infiltration of the ganglion with epithelioid cells and round cells has been held by some to be characteristic. But both the rabic tubercle and ganglion infiltration occur in other conditions. The disease is extremely rare in the United States, and the author has never seen a single case.

Symptoms.—The period of incubation of human hydrophobia is from a few weeks to several months, and it has been alleged that it may even be two years, but it is very doubtful if there is ever a period of incubation of over six or seven months. The initial symptoms are mental depression, anxiety, headache, malaise, and often pain or even congestion in the cicatrix, which symp-

toms are quickly followed by dysphagia. The difficulty in swallowing results apparently from apnea produced instantly when an attempt is made to swallow. Curtis points out that the difficulty is not spasm of the pharynx and larynx, but is a sense of immediate suffocation due to reflex stimulation of respiratory inhibition. If spasms occur—and they may occur—they are secondary to this suffocative state, a state in which the action of the diaphragm ceases for a time. The air-passages become congested and the sufferer makes frequent and painful efforts to expel thick mucus, and the efforts produce paroxysms of suffocation. Between the paroxysms the patient is evidently somewhat breathless, and Warren tells us that his speech is not unlike that "of a child who has recently been crying and is endeavoring to control itself" ("Surgical Pathology and Therapeutics"). As the condition grows worse, suffocative attacks, which were at first induced by attempts at swallowing, come to be caused also by bright lights, sudden or loud noises, irritations of the skin, or thinking of swallowing. At length suffocative paroxysms occur spontaneously and the patient jumps, or hurls himself about, or the muscles of the entire body are thrown into clonic spasm. Tonic spasm does not occur. A condition of general hyperesthesia exists. The mind is usually clear, although during the periods of excitement there may be maniacal furor with hallucinations which pass away in the stage of relaxation. The temperature is moderately elevated (101° to 103° F. or higher). The spasmodic stage lasts from one to three days, and the patient may die during this stage from exhaustion or from asphyxia. If he lives through this period, the convulsions gradually cease, the power of swallowing returns, and the patient succumbs to exhaustion in less than twenty-four hours, or he develops ascending paralysis which soon causes cardiac and respiratory failure. In what is known as *paralytic rabies*, a very rare form of the disease in human beings, the attack comes on with the same early symptoms met with in the commoner form, but paralysis soon begins about the bitten part and spreads to the other limbs and to the trunk.

In hydrophobia death is almost inevitable. Practically all cases in which it is alleged that recovery ensued were not true hydrophobia, but hysteria. An exception must be made of Murri's case (page 220). Wood says that in hysteria, especially among boys, "beast-mimicry" is common, the sufferer snarling like a dog; and in the form known as "spurious hydrophobia," in which there may or may not be convulsions, there are a dread of water, emotional excitement, snarling, and attempts to bite the bystanders (in genuine hydrophobia no attempts are made to bite, and no sounds are uttered like those made by a dog).

Lyssa is separated from lockjaw by the paroxysms of suffocation and the absence of tonic spasms in the former, as contrasted with the fixation of the jaws and the tonic spasms with clonic exacerbations of lockjaw.

Treatment.—When a person is bitten by a supposed rabid animal and is seen soon after the injury, constriction should be applied if possible above the wound, the wounded area should be excised, cauterized with a hot iron or the Paquelin cautery, and dressed antiseptically. If the patient is not seen for a number of hours or a day or two after the injury, cauterization is useless; and it is not only useless, but it may delude the patient and his friends into a feeling of security. In any case, send the patient at once to a Pasteur

institute. If the animal which inflicted the injury was not hydrophobic, no harm will result from inoculations; if it was hydrophobic, preventive treatment may save the patient. The method known as the preventive treatment was devised by Pasteur, who discovered the following remarkable facts: If the virus of a rabid dog (street rabies) be placed beneath the dura of another dog, it *always* causes hydrophobia in from sixteen to twenty days, and invariably causes death. If the virus is passed through a series of rabbits it gets stronger (laboratory virus), and if inserted beneath the dura of a dog it causes the disease in from five to six days, and kills in four or five days. The virus can be attenuated by passing it through a series of monkeys or by keeping it for a definite time. To obtain attenuated preparations in a convenient form Pasteur made emulsions from the spinal cords of hydrophobic rabbits, the animals having been dead two or three weeks. He found that the emulsion obtained from the rabbit longest dead is the weakest. He injected a dog with emulsions of progressively increasing strength and made it immune to hydrophobia. The patient is injected with an emulsion made from the dried spinal cords of hydrophobic rabbits. In this emulsion the virus is attenuated, and day by day the strength of the injected virus is increased. These emulsions cause the body-cells to form antitoxin, and either the virus of street rabies does not develop at all or by the time it begins to develop a quantity of antitoxin is present to antagonize it. In the New York Pasteur Institute patients remain under treatment for fifteen days, two inoculations being given daily. In cases in which treatment was begun late, or in which the head or face was bitten, from four to six inoculations are given each day. The report of the Parisian Pasteur Institute shows that since its foundation there has been a mortality of 0.5 per cent. The lowest estimated number of those attacked by hydrophobia before this method was used was 5 per cent. of those bitten, and all attacked died; hence, the Pasteur treatment shows one-twenty-fifth of the mortality which attends other preventive methods. The value of this plan seems definitely established. The general public believe that the dog which did the biting should be killed. The dog should, if possible, be locked up and watched rather than killed. It may be proved in this way that it did not have hydrophobia. If it were necessary to kill the dog or if the dog was killed at once or soon after, the physicians of the New York Pasteur Institute advise that the dog's head be cut from the body with an aseptic knife and a piece of the medulla oblongata be abstracted. The bit of medulla is to be placed in a mixture of equal parts of glycerin and water which was previously sterilized by boiling. The bottle should be sealed and sent to the Institute, in order that inoculations may be made upon animals to prove the existence or absence of hydrophobia. In the paroxysm of hydrophobia the treatment in the past was purely palliative. If we employ only palliative methods, keep the patient in a dark, quiet room, relieve thirst by enemata, saturate him with morphin, empty the bowels by enemata, attend to the bladder, and during the paroxysms anesthetize. Murri, of Bologna, cured a case of hydrophobia by injecting emulsions of cords of rabbits dead six, five, four, and three days respectively. It would be proper to try this remedy if hydrophobia develops.

Glanders, Farcy, or Equinia.—Glanders is an infectious eruptive fever occurring in horses and communicable to man. If the nodules occur in a

horse's nares, the disease is called "glanders"; if beneath the skin, it is termed "farcy." This disease is due to a bacillus, and is communicated to man through an abraded surface or a mucous membrane. The characteristic lesions are infective granulomata, which in the nose form ulcers and under the skin develop into abscesses.

Acute and Chronic Glanders.—In acute glanders there is septic inflammation at the point of inoculation; nodules form in the nose, and ulcerate; there is profuse nasal discharge; the glands of the neck enlarge; there are fever and an eruption like smallpox on the face and about the joints (Osler), and severe muscular pain. Acute glanders is always fatal. Chronic glanders lasts for months, is rarely diagnosticated, being mistaken for catarrh, and is often recovered from. The diagnosis can be made by injecting a guinea-pig with the nasal mucus.

Acute and Chronic Farcy.—Acute farcy arises at the site of a skin-inoculation; it begins as an intense inflammation, from which run out inflamed lymphatics that present nodules or "farcy-buds." Abscesses form. There are joint-pain and the constitutional symptoms of sepsis, but no involvement of the nares. Chronic farcy may last for months. In it nodules occur upon the extremities, which nodules break down into abscesses and eventuate in ulcers resembling those of tuberculosis.

Treatment.—In treating this disease the point of infection is at once to be incised and cauterized, dusted with iodoform, and dressed antiseptically. The skin over enlarged glands and swollen lymphatics is to be painted with iodin and smeared with ichthyol. Bandages are applied to edematous extremities. Ulcers are curetted, touched with pure carbolic acid, dusted with iodoform, and dressed antiseptically. The nostrils should be sprayed at frequent intervals with peroxid of hydrogen, and frequently syringed with a solution of sulphurous acid. The mouth must be rinsed repeatedly with solutions of chlorate of potassium. Abscesses are to be opened, mopped with pure carbolic acid, and dressed antiseptically. Stimulants and nourishing diet are imperatively demanded. Morphin is necessary for the muscular pain, restlessness, and insomnia. Digitalis is given to stimulate the circulation and kidney secretion. Sulphur iodid, arsenite of strychnin, and bichlorate of potassium have been used. Diseased horses ought at once to be killed and their stalls should be torn to pieces, purified, and entirely rebuilt. A man with chronic glanders should be removed to the seaside. The nasal passages must be kept clean and the ulcers must be cauterized and dressed with iodoform gauze. Nutritious foods, tonics, and stimulants are necessary.

Actinomycosis is an infectious disorder characterized by chronic inflammation, and is due to the presence in the tissues of the *actinomyces*, or ray-fungus. This disease occurs in cattle (lumpy jaw) and in pigs, and can be transmitted to man, usually by the food. At the point of inoculation (which is generally about the mouth) arises an infective granuloma, around which inflammation of connective tissue occurs, suppuration eventually taking place. Inoculation in the mouth is by way of an abrasion of mucous membrane or through a carious tooth. Chewing straw which contains the fungi is the most common method of infection. The ray-fungi may pass into the lungs, causing pulmonary actinomycosis; into the intestines, causing intestinal actinomycosis; into the skin, the bones, the subcutaneous tissues, the heart, the

brain, the liver, etc. Cases of human actinomycosis until very recently were looked upon as sarcomata. Many sinuses form, but large abscesses do not arise.

The pus of actinomycosis contains many sulphur-yellow bodies, visible to the naked eye and composed of fungi. These bodies feel gritty when rubbed between the fingers because of the presence of lime salts.

In actinomycosis the adjacent lymph-glands are very rarely involved, and if metastasis occurs it takes place by the veins. The condition causes but slight pain. A diagnosis must be made from syphilis, sarcoma, and tuberculosis. The formation of a tumor, followed by sinuses, the appearance of the pus, and the microscopic study of the discharge are significant. It is well to remember that an individual with actinomycosis reacts to tuberculin like a person with tuberculosis. Actinomycosis may last for years, or it may prove fatal.

Cutaneous actinomycosis may be secondary to visceral infection with the disease, may be a purely local condition, or may be associated with some adjacent area of bone-infection. The gummatous form of actinomycosis resembles a gummatous syphilitic area, and in it many small purulent pockets open by fistulæ (Monestié).

In the anthracoid form there are no distinct purulent collections, but many fistulæ discharge pus at various points (Monestié).

An area of cutaneous actinomycosis is characterized by the existence of violet, blue, gray, or black maculæ, varying in size from that of a pin's head to that of a bean, the center of each macule being white and containing a minute quantity of pus (Derville).

In actinomycosis of bone the bone enlarges and becomes painful, the parts adjacent swell from infiltration and soften, pus forms and reaches the surface through fistulæ, and the skin becomes involved secondarily.

Abdominal actinomycosis takes origin from the gastro-intestinal tract, an actinomycotic nodule of the intestine having ulcerated, adhesions having formed, and an actinomycotic abscess having arisen, or actinomycotic disease of the intestine having spread. Over fifty per cent. of such conditions attack the cecum. A fecal fistula may form and the liver may be involved. The prognosis of actinomycosis is reasonably good in many cases. The majority of cutaneous cases and many osseous cases can be cured. The mortality in the abdominal cases is large. Grill says that of 77 abdominal cases treated surgically 45 died, 22 recovered, and 10 were improved. Actinomycosis has a strong tendency to redevelop even after apparently thorough excision. A case of cutaneous actinomycosis of the arm, seen by the author, was operated on twenty times. Ulceration took place into the axillary artery and death was narrowly averted. Recovery finally ensued.

Treatment.—Free excision if possible; otherwise incision, cauterization with pure carbolic acid, and packing with iodoform gauze. Give internally large doses of iodid of potassium. This drug alone has cured many cases.